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Title:
Rocket engines

TECHNICAL FIELD

The present invention relates to a liquid fuel rocket engine member having a load bearing wall structure comprising a plurality of cooling channels.

BACKGROUND OF THE INVENTION

During operation, a rocket engine member wall structure like a nozzle or a combustion chamber is subjected to very high stresses, for example in the form of a very high temperature on its inside (in the order of magnitude of 800 °K) and a very low temperature on its outside (in the order of magnitude of 50 °K). As a result of this high thermal load, stringent requirements are placed upon the choice of material, design and manufacture of the wall structure. At least there is a need for effective cooling of the wall structure.

Its a problem to construct cooled wall structure that are capable of containing and accelerating the hot exhaust gas and to be able to do this in a reliable way for a large number of operation cycles. The present solutions do not have a sufficient long service life required for a large number of operation cycles. The present systems generate large thermal stresses, include large pressure drops or present difficulties when needing repair.

SUMMARY OF THE INVENTION

An object of the present invention is therefore to provide a rocket engine member with a reduced heat load on the load bearing wall structure.

This is achieved by means of the member according to the invention, which is characterized in that a material with a higher thermal conductivity than the load bearing wall structure has been applied to said wall structure.

As a result of the invention, a rocket engine member may be manufactured which presents high pressure capacity, a long cyclic life as well as advantageous area ratio.

Advantageous embodiments of the invention can be derived from the subsequent contingent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described in the following, in a non-limiting way with reference to the accompanying drawings in which:

FIG 1 is a schematic side view showing a rocket nozzle having a wall structure according to the invention,

FIG 2 is a partial sectional view along the line A-A in Fig. 1, showing a wall structure section, according to a first embodiment of the invention, and

FIG 3 is a partial sectional view along the line A-A in Fig. 1, showing cooling channels at the inlet end of the nozzle, according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a diagrammatic and somewhat simplified side view of an outlet nozzle 10 that has been produced in accordance with the present invention. The nozzle is intended for use in rocket engines of the type using liquid fuel, for example liquid hydrogen. The working of such a rocket engine is previously known per se and is therefore not described in detail here. The nozzle 10 is cooled with the aid of a cooling medium that is preferably also used as fuel in the particular rocket engine. The invention is however not limited to outlet nozzles nor outlet nozzles of this type, but can also be used for rocket combustion chambers and in those cases in which the cooling medium is dumped after it has been used for cooling.

The outlet nozzle is manufactured with an outer shape that is substantially bell-shaped. Thus, the nozzle 10 forms a body of revolution having an axis of revolution and a cross section that varies in diameter along said axis.

The nozzle wall is a structure comprising a plurality of mutually adjacent, tubular cooling channels 11 extending substantially in parallel to the longitudinal axis of the nozzle from the inlet end 12 of the nozzle to its outlet end 13. The outside of the structure includes a continuous sheet metal wall 14. The tubular cooling channels 11 are curved in the longitudinal direction to conform to the nozzle contour and they are axially oriented along the nozzle wall, in this position, they are jointed to the metal wall by welding. The welds are preferably made by laser welding from the outside. This assembly forms a leak

tight nozzl with all joints at the cool side of the wall structure.

The cooling channels 11 in the embodiment according to Fig. 2 and 3 are circular tubes 15 having a varying cross section. The tubes 15 may be seamless and have a smaller cross section at the inlet end 12 of the nozzle than at the opposite end.

Fig. 2 shows a section of the wall structure. The inside of the wall has been coated with a thermally conductive material 17 for increased heat transfer from the sheet metal wall 14 to the tubes 15. This makes it possible for each tube 15 to cool a larger part of the circumference and therefore, the available number of cooling channels may cool a larger diameter. At the same time, the cross sectional area of the channels may be rather small. In this manner, the pressure capacity of the cooling channels can be high. In a case where the conductive material, e.g. copper or silver, completely fills the cavity, it is possible to reach very high pressures and high area ratios.

The process to apply the conductive material may include brazing or laser sintering. By introducing a conductive material in the space between the cooling channels, it is possible to increase the spacing of channels and thereby reach large nozzle area ratios without increasing the cooling channel cross section too much to maintain the pressure capacity.

Fig. 3 shows a second embodiment of the invention where U-formed profiles 18 are used instead of the above-described

circular tubes 15. The profiles have a varying cross section and a varying material thickness. The profiles are manufactured by press forming sheet metal strips. Normally, the profiles are manufactured from stainless steel and superalloys in order to provide the necessary strength and manufacturing feasibility. The life expectancy of those parts of the rocket element that is subjected to a high thermal load, as these materials have a low capacity of heat transmission. According to the invention, this is avoided by the use of the thermally conductive material 17 to reduce the area that the wall exposes to the flame. Also, the surface of the channel profile that is exposed to the heat is increased, as the thermally conductive material distributes the heat to a large part of the channel profile. Both these measures, together or separately, reduces the heat input per area unit of channel profile. In practice, the heat input is reduced by about 20-30 % and this input is distributed over an increased (about 50 %) surface area according to the shown configuration.

The variation in profile thickness is adapted to the length of the nozzle. The surface or the thickness distribution of the profiles may also be modified to enhance cooling or strain distribution. The thermally conductive material 17 is thick enough to completely cover the profiles 18. Also the outside of the wall section has been coated with a layer 19 of the thermally conductive material, e.g. copper.

It is possible to build the structures described above from the common materials for rocket engine nozzle tubes such as stainless steel and nickel based alloys.

The nozzle extension could be built less costly since the heat load is limited.

The rotational symmetric surface of the nozzle structure according to the invention provides stiffness itself and, if necessary, allows for attachment of stiffeners in an easy way.

The invention is not limited to the above-described embodiments, but several modifications are possible within the scope of the following claims. For example, the improved cold wall structure may also be applied to external expansion engines like round and linear aero-spike engines.

C.13538, 2001-01-09

CLAIMS

1. A liquid fuel rocket engine member (10) having a load bearing wall structure (14, 15) comprising a plurality of cooling channels (11),
c h a r a c t e r i z e d in
that a material (17) with a higher thermal conductivity than the load bearing wall structure (14, 15) has been applied to said wall structure.

2. A member according to claim 1,
c h a r a c t e r i z e d in
that the material (17) has been applied to the inside of the wall structure (14, 15).

3. A member according to claim 1 or 2,
c h a r a c t e r i z e d in
that the material (17) has been applied between the cooling channels (11).

4. A member according to any one of claims 1-3,
c h a r a c t e r i z e d in
that the material (17) surrounds the cooling channels (11).

5. A member according to any one of claims 1-4,
c h a r a c t e r i z e d in
that the material (17) is also positioned at the outside of the wall structure (14, 15) as a layer (19).

6. A member according to any one of claims 1-5,
c h a r a c t e r i z e d in

that the material (17) comprises copp r.

7. A member according to any one of claims 1-5, c h a r a c t e r i z e d in that the material (17) comprises silver.

8. A member according to any one of claims 1-7, c h a r a c t e r i z e d in that material (17) has been applied by brazing.

9. A member according to any one of claims 1-7, c h a r a c t e r i z e d in that material (17) has been applied by laser sintering.

10. A member according to any one of claims 1-9, c h a r a c t e r i z e d in that the outside of the wall structure includes a continuos sheet metal wall (14), and that the cooling channels (11) are longitudinally attached to the structure of the sheet metal wall.

ABSTRACT

The invention relates to a liquid fuel rocket engine member (10). The member has a load bearing wall structure (14, 15) comprising a plurality of cooling channels (11). For improving the heat transfer, a material (17) with a higher thermal conductivity than the load bearing wall structure (14, 15) has been applied to the wall structure.

(Fig. 2)

Fig.1

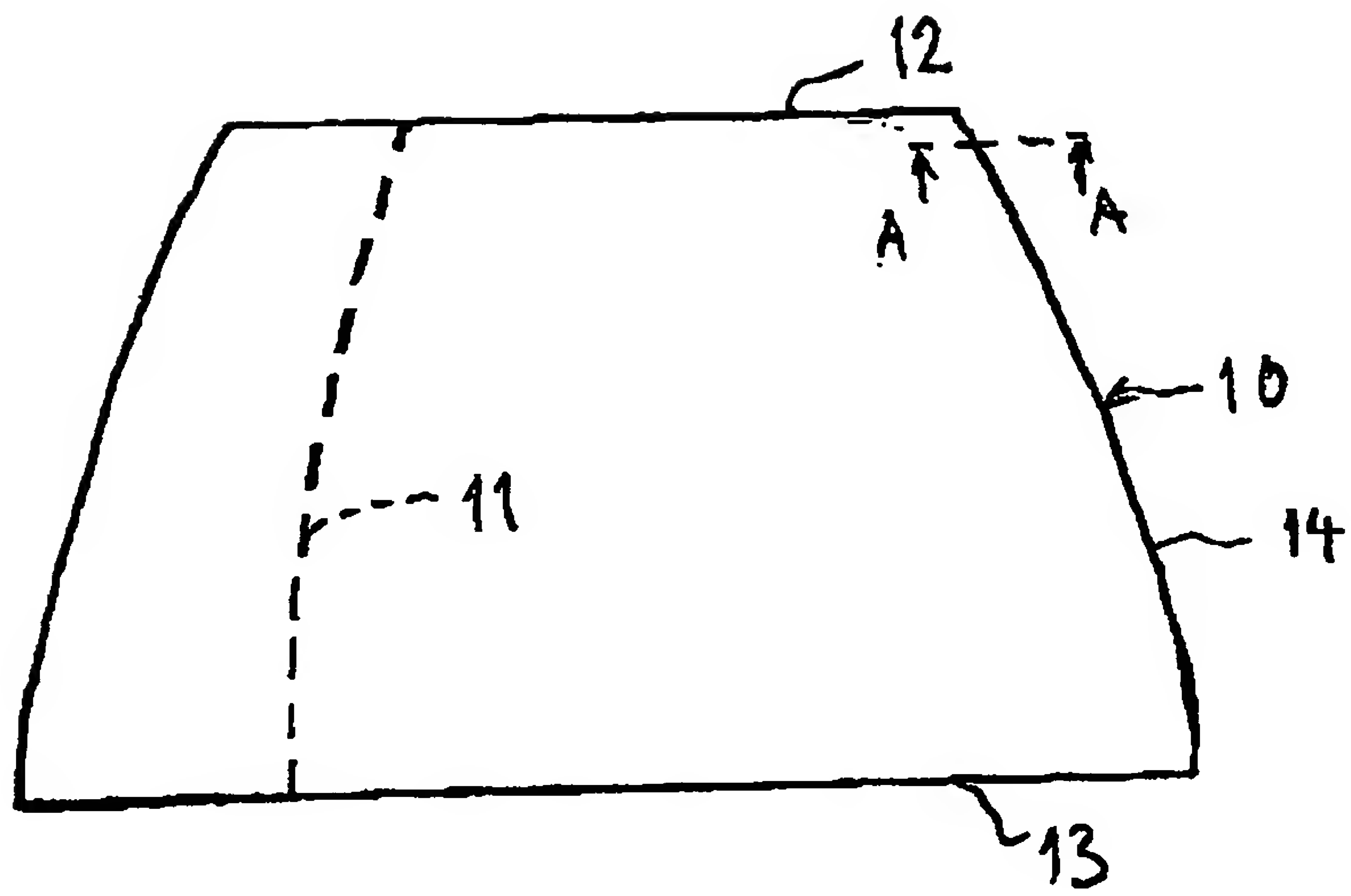

Fig.2

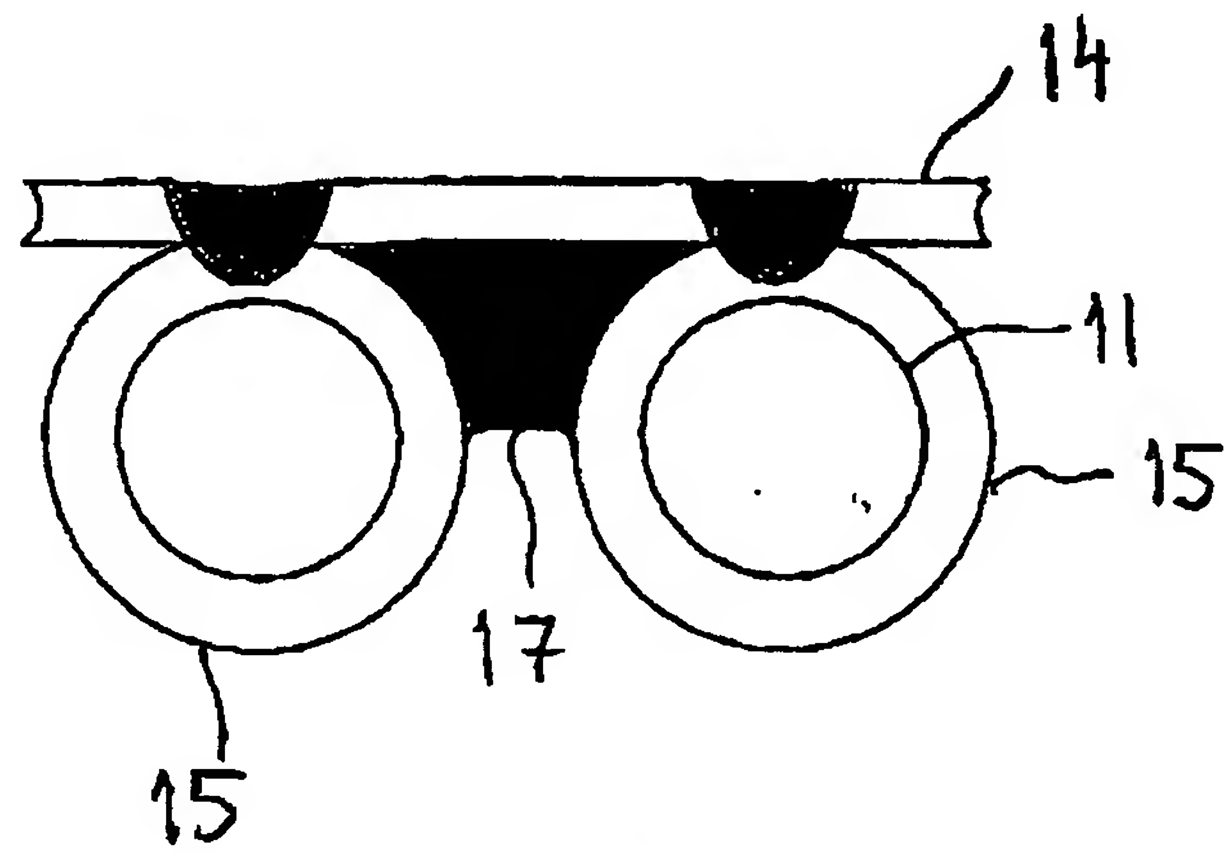

Fig.3